NON-PUBLIC?: N
ACCESSION #: 9308250013
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Catawba Nuclear Station, Unit 1 PAGE: 1 OF 08

DOCKET NUMBER: 05000413

TITLE: Reactor Trip and Auxiliary Feedwater System Automatic
Start
EVENT DATE: 07/18/93 LER #: 93-008-00 REPORT DATE: 08/17/93

OTHER FACILITIES INVOLVED: N/A DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: R. C. Futrell, Compliance Manager TELEPHONE: (803) 831-3665

COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE NPRDS:

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On July 18 at 2031 hours, with Unit 1 in Mode 1, Power Operation at 100% power, a Reactor Trip occurred due to low-low level in Steam Generator (S/G) 1A. Engineering was replacing a backup processor in the Digital Feedwater Control System (DFCS). As the processor was inserted the redundant processor failed, causing Main Feedwater (CF) and all S/G controls to swap to Manual and several Control Room (C/R) indications for S/G 1A to be driven to zero. This led C/R Operators to believe CF flow was lost, therefore they opened a CF valve to restore flow. When a S/G 1A High High Level Alert annunciator was received, CROs realized flow had not been lost and began to close the CF valve. The resulting transient caused the low-low S/G 1A level and Reactor Trip. On July 19 at 0030 hours, with Unit 1 in Mode 3, Hot Standby, Engineering was restoring the DFCS when an Auxiliary Feedwater System autostart occurred. The output control card (QAM) for CF Pump 1A speed control had swapped to its backup QAM. Upon reset to the primary QAM, with the backup in manual mode, a

positive step change occurred causing CF Pump 1A to trip due to high discharge pressure. These incidents are attributed to Equipment Specification/Manufacture due to special installation instructions that were not provided. Corrective actions include a review of failure modes for DFCS, a review of spare DFCS parts, and procedure revisions.

END OF ABSTRACT

BACKGROUND

The Main Feedwater EIIS:SJ! (CF) System consists of two turbine EIIS:TRB! driven Feedwater Pumps EIIS:P!, two stages of high pressure feedwater heaters (A and B), piping EIIS:PSP!, valves EIIS:V!, and instrumentation. Normally, both feedwater pumps will be operating with each pump handling half the feedwater flow. Downstream of the feedwater pumps, the feedwater passes through two stages of high pressure heaters to a final header where the temperature is equalized. The feedwater is then admitted to the Steam Generators EIIS:HX!(S/G) through four S/G feedwater lines, each of which contains a control valve, bypass valve, and flow nozzle.

The Digital Feedwater Control System (DFCS) provided by Westinghouse automatically controls feedwater flow to the Steam Generators (S/G) to maintain proper S/G water levels. Feedwater flow is controlled by control valves and feedwater pump speed. The DFCS hardware is contained in four cabinets in the Control Room designated as Cabinets 5, 6, 7, and 8. Cabinet 5 contains controls for S/G A and both feedwater pumps. Within each cabinet are two "Drop" locations that contain redundant (Primary and Backup) digital processors (MSQs), memory expansion cards (MMEs), and communication links. A continuous feedback loop exists between the Primary and Backup processors to ensure that, upon failure of the Primary processor, a bumpless transfer to the Backup processor occurs and no transient is induced on the S/G level control system. The hardware locations for the Primary and Backup processors with each cabinet are designated as follows: Cabinet 5, Drop 5 and Drop 55; Cabinet 6, Drop 6 and Drop 56, etc. Processor redundancy is implemented using a masterless scheme, that is, either processor can run as the Primary while the remaining processor is in Backup mode. In addition, redundant analog output cards are provided. The Auto/Manual cards (QAMs) provide a demand analog signal to a control device (i.e. valve) as well as setpoint/demand signals to the Auto/Manual control station. Two different modes of operation are possible. In Automatic mode, signals are received from the Input/Output bus and in Manual mode signals are received from the operator pushbuttons at the Control Room Auto/Manual station. This

portion of the system is also designed such that, upon QAM failure, a bumpless transfer occurs. An Engineer Console is also provided that includes a monitor, keyboard, and printer to allow review of system status.

The Auxiliary Feedwater EIIS:BA!(CA) System assures sufficient feedwater supply to the S/Gs in the event of loss of the CF System, to remove energy stored in primary coolant and residual core energy. The system is designed to start automatically in the event of loss of offsite power, trip of both CF pumps, safety injection signal, or low-low S/G water level; any of which may

result in, coincide with, or be caused by a Reactor Trip. In addition, the CA System will supply sufficient feedwater flow to maintain the Reactor at hot standby for two hours followed by cooldown of the Reactor Coolant EIIS:AB! (NC) System to the temperature at which the Residual Heat Removal EIIS:BP! (ND) System may be operated.

The Reactor Protection System EIIS:JC! (IPX) is designed to trip the Reactor or actuate appropriate safeguards equipment in time to prevent violating any plant safety limits. A Reactor Trip signal is generated upon receipt of low-low S/G level on 2/4 channels on 1/4 S/Gs.

EVENT DESCRIPTION

On July 17, 1993, with Unit 1 in Mode 1, Power Operation at 100% power, a "Drop 5 Timeout" alarm was received on the Digital Feedwater Control System (DFCS) indicating a failure associated with the Cabinet 5 Backup Processor (Drop 5). The Primary Processor (Drop 55) continued to function normally with no effect on the system. Component Engineering Services (CES) personnel reported onsite on July 18 at approximately 1300 hours to investigate the malfunction further. Due to the delicate nature of the work and lack of available qualified technicians, a decision was made to delay repair until July 19 (Monday).

On July 18 at 1722 hours a "Drop 56 Timeout" alarm was received from DFCS Cabinet 6. Drop 56 was acting as the Primary Processor, therefore DFCS control swapped to the Backup Processor in Drop 6. During this swapover, the "DFCS NOT IN AUTO" annunciator EIIS: ANN! was received in the Control Room and the CF pumps swapped to Manual control. CES personnel returned onsite and determined that a successful transfer to the Backup Processor had occurred and directed the Control Room Operator (CRO) to return the CF pumps to AUTO.

At approximately 1900 hours, qualified Instrumentation and Electrical (IAE) technicians arrived onsite. At that time, efforts were concentrated toward resolving the problem in Cabinet 5 Drop 5 since it contains controls for both CF pumps as well as S/G 1A. CES and IAE tried rebooting the processor and reseating the cards in Drop 5, however these actions did not resolve the problem. CES determined that the problem existed with either the processor (MSQ) or the memory card (MME). A decision was made to pursue replacement of the Backup Processor (MSQ) in Drop 5. A replacement was obtained from the warehouse and setup for installation.

Prior to installation of the replacement processor, a tailgate meeting was held between CES, IAE, and Operators. CES informed the CROs that they may see feedwater controls swap to Manual during this work activity. Other than a swap to Manual, no other perturbations were anticipated.

At approximately 2030 hours, as the replacement processor was inserted into the back plane connector in Drop 5, the Primary Processor in Drop 55 failed. At this point both the Primary and Backup Processors in Cabinet 5 were not functioning, resulting in the "DFCS NOT IN AUTO" annunciator being received in the C/R and feedwater controls being swapped to Manual. In addition, the following Main Control Board indications were driven to zero: CF flow to S/G 1A, Main Steam EIIS:SB! (SM) flow from S/G 1A, CF/SM DP, CF/SM DP setpoint, S/G 1A Inlet Header Pressure, Narrow Range (N/R) level chart recorder for S/G 1A, and valve positions for 1CF28, Main Feed Reg Valve, and 1CF30, Main Feed Bypass Valve (indicated closed). This led the CRO to believe that 1CF28 was closed and that CF flow to S/G 1A had been lost. The CRO subsequently opened 1CF28 to restore flow to S/G 1A. Due to the DFCS failure, the "S/G 1A Level Deviation" annunciator was not received. Upon receipt of "S/G 1A Hi Hi Level Alert" annunciator, the CRO realized that 1CF28 was open and immediately commenced closing 1CF28. As the CRO began to observe level turning on the Wide Range level indication, he began to open 1CF28 again in an attempt to prevent a S/G low level condition. However, at 2031 hours, a S/G 1A Lo Lo Level Reactor Trip occurred.

Following the Reactor Trip, CES/IAE investigated the cause for the failure of both processors in DFCS Cabinet 5. The original processor (MSQ) that had been removed from Cabinet 5 Drop 5 was reinstalled and the memory card (MME) in Drop 5 was changed out. After this action, Cabinet 5 Drop 5 functioned properly. In addition, the Processor in Cabinet 6 Drop 56 was turned off (cold boot and had its memory backloaded. Following this action, Drop 56 functioned properly. At this time, all DFCS cabinets and associated processors were functioning properly.

On July 19 at 0030 hours with Unit 1 in Mode 3, Hot Standby, CF Pump 1A was in operation with CF Pump 1B tripped. CES was in the process of returning the DFCS to normal status. CES was reviewing system status at the Engineer Console when it was noticed that CF Pump 1A speed control had swapped to its backup output card (QAM). CES proceeded to swap control to the primary QAM, unaware that the backup QAM was in MANUAL mode. Thus, when control was returned to the primary QAM, a positive step change in the demand signal to CF Pump 1A occurred. This caused the CF Pump speed to increase suddenly, resulting in a CF Pump 1A High Discharge Pressure trip. With both CF pumps in the tripped condition, a CA

Autostart occurred. CROs entered AP/1/A/5500/06, Loss of S/G Feedwater, and recovered from this event.

CONCLUSION

The Reactor Trip is attributed to Equipment Specification, Manufacture due to special installation instructions that were not provided by Westinghouse. Prior to startup of the DFCS, Westinghouse identified a need to upgrade the DFCS processors (MSQs). Changeout of all processors installed in the DFCS was accomplished prior to startup of the system, however, spare processors in stock were not removed. Westinghouse later issued a technical report outlining a set of instructions to be used when installing MSQ type processors. This report was not forwarded to Duke Power for awareness or action. Per Westinghouse, had this set of instructions been used during installation of the spare processor, no failure would have occurred on the redundant (Drop 55) processor in Cabinet 5. In addition, it is necessary to follow these instructions during insertion of any MSQ type processor to ensure conflicts between redundant processors do not exist. Westinghouse representatives have agreed to include Duke Power on future correspondence related to the DFCS. Also, a general troubleshooting procedure will be developed for corrective maintenance on DFCS that will include the special instructions for installing MSQ type processors. This procedure will also instruct users, when replacing processors/cards, to ensure that previous revision level components are not installed without validation from Westinghouse. For interim measures until the procedure is developed, these requirements have been reviewed with all DFCS qualified IAE technicians for awareness. To ensure that the warehouse stock at Catawba does not contain any cards that Westinghouse is not aware of, a review of all DFCS cards (including subgroup numbers) will be performed. The results of this review will be forwarded to Westinghouse for validation. The two spare processors originally targeted for changeout were removed from stock. The details of this event have been forwarded to the Duke Power Quality Verification

Vendor Group for consideration of a program review of the DFCS supplier.

The failure of both processors in DFCS Cabinet 5 was not previously considered a viable failure mode. As a result of this event, Engineering will review this failure, as well as other possible failure modes that could affect the DFCS. If any needed changes (modifications, training, etc.) are identified as a result of this review, Engineering will coordinate these actions with the responsible groups.

Prior to replacement of the Backup Processor in DFCS Cabinet 5, a tailgate meeting was held between CES/IAE and Operators. CES informed CROs that they may see, feedwater controls swap to Manual during this activity. No other system responses were anticipated by CES or by Operators. As the spare processor was inserted into the system, CF pump and all S/G controls swapped to Manual and several Control Room indications for S/G 1A were driven to zero. This led Operators to believe that feedwater flow had been lost. When CROs attempted to restore feedwater flow, a level transient was induced that resulted in a Reactor Trip. Although Operator action was not identified as a causal factor of this event, Operations has issued an Operator Update which describes this event and lessons learned.

During this event, CES/IAE attempted to return the Primary Processor in DFCS Cabinet 5 to service as quickly as possible after they realized that both processors were lost. This involved a review of system status using the Engineer Console. Lessons learned from this event indicate that, upon failure of both processors, it is possible to reset the processor not being worked on locally at the Cabinet without referring to the Engineer Console. This action would restore Control Room indications more quickly, thus reducing the impact on Operators. This event, and lessons learned, were reviewed with all DFCS qualified IAE technicians.

The CA autostart on July 19 at 0030 hours is attributed to Equipment Specification, Manufacture. Since the spare processor was installed without using the special instructions from Westinghouse, both processors in DFCS Cabinet 5 were lost. This caused key DFCS status information on the Engineer Console to be incorrect. CES was in the process of returning the DFCS to normal status when it was noted that the backup QAM for CF Pump 1A speed control was inservice. Normal system alignment requires that the primary QAM be inservice. At this point, the backup QAM was in Manual mode and an onscreen fault message indicated Backup QAM Not In Auto". The Engineer Console will normally place a DEFEAT message onscreen as well as indicate a red condition in the "Drop Fault Reset" block when a QAM swaps to its backup control card or when an fault message is indicated. Neither

the DEFEAT message or the red condition were indicated, therefore CES swapped control back to the primary QAM. With the backup QAM in Manual, this caused a positive step change in the demand signal to CF Pump 1A and a subsequent High Discharge Pressure trip. With both CF pumps in the tripped condition, a CA autostart occurred. CROs entered AP/1/A/5500/06 and recovered from this event.

CES will develop a DFCS status checklist to be used prior to system startup and following corrective maintenance. This checklist will be included in the Model Work Orders for responding to the DFCS Trouble annunciators. In addition, Operations will revise Mode 3

checklists and the alarm procedures for the DFCS Trouble annunciator to ensure the subject Model Work Orders are issued when required. Use of this checklist will direct the user to review Engineer Console screens for system status as well as status/fault messages. Also, Westinghouse has agreed to review the processor startup and initialization process to determine if the system is setup properly to reflect accurate status indicators (such as DEFEAT switches) for the Engineer Console. Any necessary changes will be coordinated by CES.

A review of reportable events for the past two years did not reveal any Reactor Trips or CA autostarts due to problems associated with DFCS or vendor installation instructions. Therefore, this event is not recurring.

CORRECTIVE ACTIONS

SUBSEQUENT

1) Westinghouse representatives have agreed to include Duke Power on future correspondence related to the DFCS.

2) All previous revision spare DFCS processors were removed from warehouse stock.

3) This event and lessons learned were discussed with all DFCS qualified IAE technicians. This included a review of requirements for changeout of DFCS processors/cards.

4) CROs entered AP/1/A/5500/06 and recovered from the CA autostart.

5) Operations issued an Operator Update describing this event and lessons learned.

6) The details of this event have been forwarded to the Quality Verification Vendor Group for consideration of a program review of the DFCS supplier.

PLANNED

1) A general troubleshooting procedure will be developed for corrective maintenance on DFCS.

2) Perform a review of spare cards, including subgroup numbers, and obtain validation of these cards from Westinghouse.

3) Perform a review of this event, as well as other possible failure modes that could affect DFCS.

4) Develop a DFCS status checklist and incorporate into Model Work Orders for the DFCS Trouble annunciators.

5) Revise alarm response procedures and Mode 3 checklists for issuing the Model Work Orders for the DFCS Trouble annunciators.

6) Coordinate with Westinghouse a review of DFCS processor startup and initialization relative to Engineer Console status indicators.

SAFETY ANALYSIS

Unit 1 was in Mode 1 at 100% power upon receipt of a Reactor Trip signal. The trip occurred due to low-low level in S/G 1A as designed. All control rods EIIS:ROD! inserted normally in the core. No primary or secondary Power Operated Relief Valves or Safeties lifted during this transient. Control Room Operators responded properly to stabilize primary and secondary systems. All safety systems responded as expected during this event.

Unit 1 was in Mode 3 upon receipt of the CA autostart. The CA autostart provides a safety related source of feedwater to the S/Gs when CF is not available. During these conditions, the CA system removes energy from the NC system to prevent overpressurization of the NC system. The CA motor EIIS: MO! driven pumps started as designed and provided flow to the S/Gs as required. Control Room Operators entered the appropriate response procedure and recovered from this event.

The health and safety of the public were not affected by this event.

ATTACHMENT 1 TO 9308250013 PAGE 1 OF 1

Duke Power Company (803)831-3000
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York, SC 29745

DUKE POWER

August 17, 1993

Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Catawba Nuclear Station
Docket No. 50-413
LER 413/93-008

Gentlemen:

Attached is Licensee Event Report 413/93-008, concerning REACTOR TRIP AND AUXILIARY FEEDWATER SYSTEM AUTOMATIC START.

This event was considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

D. L. Rehn

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